DATABASE SYSTEMS

Introduction to MySQL

Database System Course, 2016

TEL AVIV UNIVERSITY

AGENDA FOR TODAY

- **Administration**
- **Database Architecture on the web**
- **Database history in a brief**
- **Databases today**
- **MySQL**
  - What is it
  - How to use it
- **Homework**

ADMINISTRATION

- **Me** (email, office, office hours)**:** cs.tau.ac.il/~amitsome
- **About the recitations:**
  - 3 of the course lectures are recitations:

    1. This one (introduction to MySQL and how to use it in HW#1)
    2. DB programming (How to correctly use the DB programmatically, useful for the final project)
    3. Web programming (How to build a web UI, useful for the final project)
  - Will focus *only* on the practical side of database programming
  - Suppose to help you with the final project, but not to explain you Tova's lectures.
  - Attendance is not mandatory. However, the material, pointers and directions I give in class are valid, and ignoring them might effect your project final grade.

ADMINISTRATION

About our forum:

- http://courses.cs.tau.ac.il/0368-3458/forum
- It works like StackOverflow: you vote up, vote down and select the best answers.
- Please use meaningful titles and devote some time to phrasing your question so everyone can understand.
- Material related questions will not be answered elsewhere. Don't ask me what is a left-outer join in a private email because I will not answer.
- **Final grade bonus**: will be given to the top 5 users in the forum (rank): [1,2,3,4,5] for [5th, 4th, 3rd, 2nd, 1st)

ADMINISTRATION

Homework Submission

- Submission date is on the website.. (No late arrivals will be accepted)
- Work should be done in pairs
- Submission is done via moodle, by one of the partners
- Submit a zip file, with
  - an answers pdf that contains the full names and IDs of both partners on top of the page
  - A .sql file for every query. **Make sure it's runnable.**

ADMINISTRATION

The final project

- You will build a website with a database.
- However the focus will be on the database design, optimization, SQL queries, and DB programming best practices. We do not care how pretty your UI is, though we can give you bonus points for that.
- It's really useful and practical project, since today everything is web-based.
- Work in groups of 4-5.
- It is a lot of work, **so start early**
- One Milestone (see dates on the website)
- You can choose between PHP or Python.

ADMINISTRATION

System support

- During this class, you will use several servers/framworks belonging to the university e.g. Nova , Mysql server, and the python/php web-server.
- If you encounter a system problem, you have to email **system@cs.tau.ac.il**. They are really nice and will help you if you encounter problems.

Technical Issues

- Remember that MySQL, SQL, Database programming and web programming are among the most common topics in the computer science community.
- Use google, use Stackoverflow, watch tutorials and video lectures.

Other Issues

- Use the Moodle forum for non-technical questions e.g. finding partners
- Email me if you have a private problem that will most certainly not be of interest to other students
- Come to my office hours (by appointment)!

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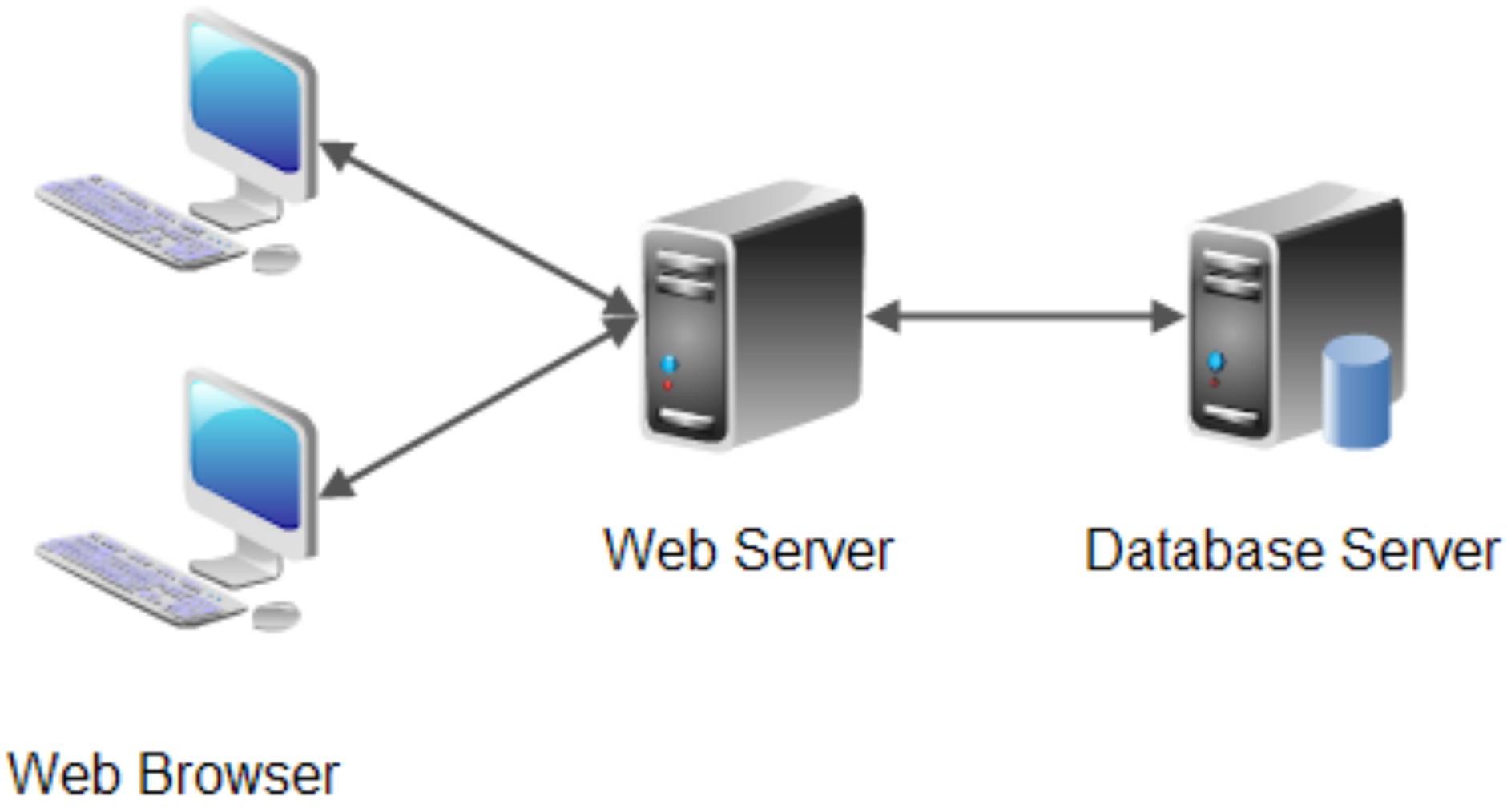
DATABASE ARCHITECTURE ON THE WEB (BRIEF)

- Database server is a **standalone** server.
- Database server is not accessible to web-users (when configured securely)
- Only the web server communicates with the DB.
- Administrators have special permissions to access to the database management system directly.

DATABASE ARCHITECTURE ON THE WEB (ILLUSTRATION)



DATABASE ARCHITECTURE ON THE WEB (EXTENDED)

- Database is a process, running within an operation system on a physical or virtual server.
- When running, the data base software process binds a listening network port on a local interface.
- A web server is also a process, binding a listing port.
- **Security configuration (e.g. in a Firewall)**

  Only the web server is allowed to connect to the DB port.

  Administrator user is allowed to connect to the DB port directly (in a secured connection, like you soon….^_^)

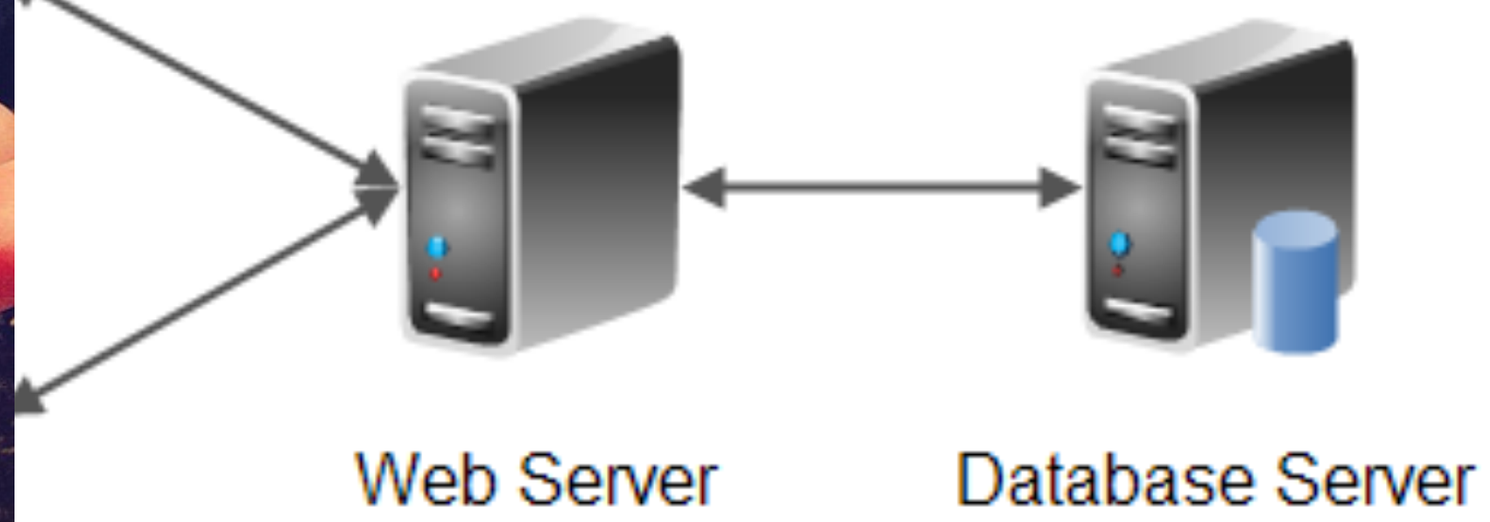
  The web server is open to web-users.

DATABASE ARCHITECTURE ON THE WEB (EXTENDED)

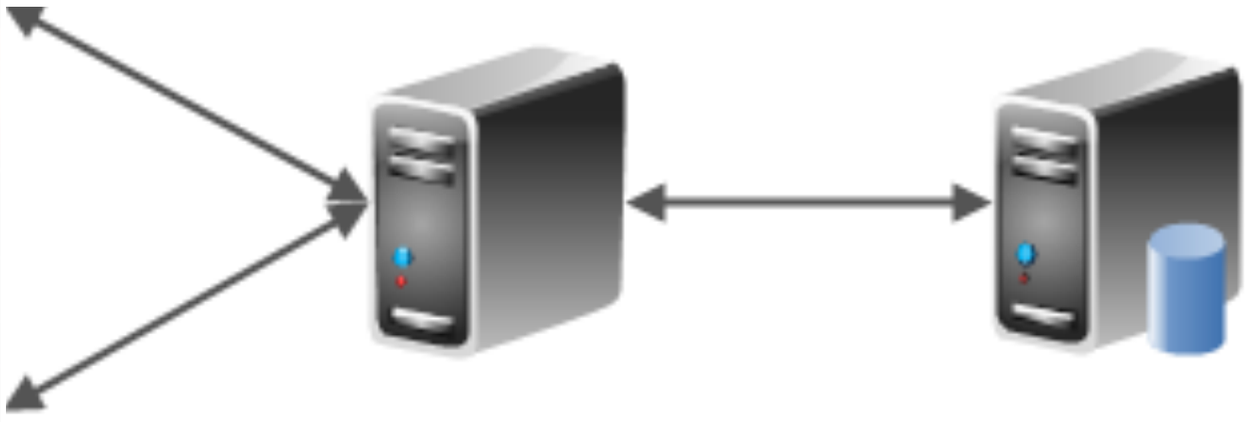
- **Web session illustration in 6 simple stages**

1. A client opens a web browser in her computer
2. Within the web browser she type the URL of a website (e.g. ynet.co.il)
3. The browser issues an HTTP session to request the website's content.
4. The web server receive the HTTP request
5. The web server connects to the DB server to retrieve data (e.g., current articles of today)
6. The web server returns the client the content of the page.

HOW DOES INSTAGRAM WORKS?



HOW DOES INSTAGRAM WORKS?



Web Server

Database Server

★ Image Processing
★ UI operations

★ Authentication
★ Notifications
★ API

★ Images table
★ Users table

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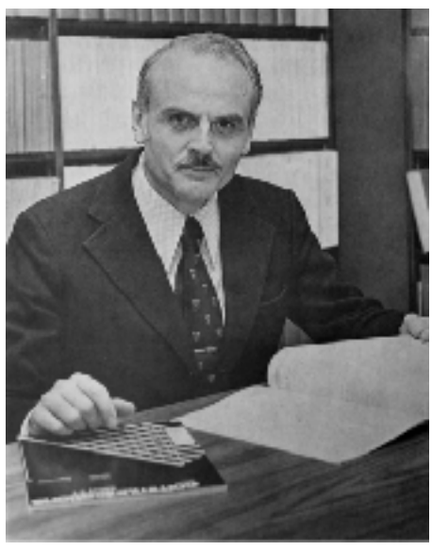
DATABASE HISTORY

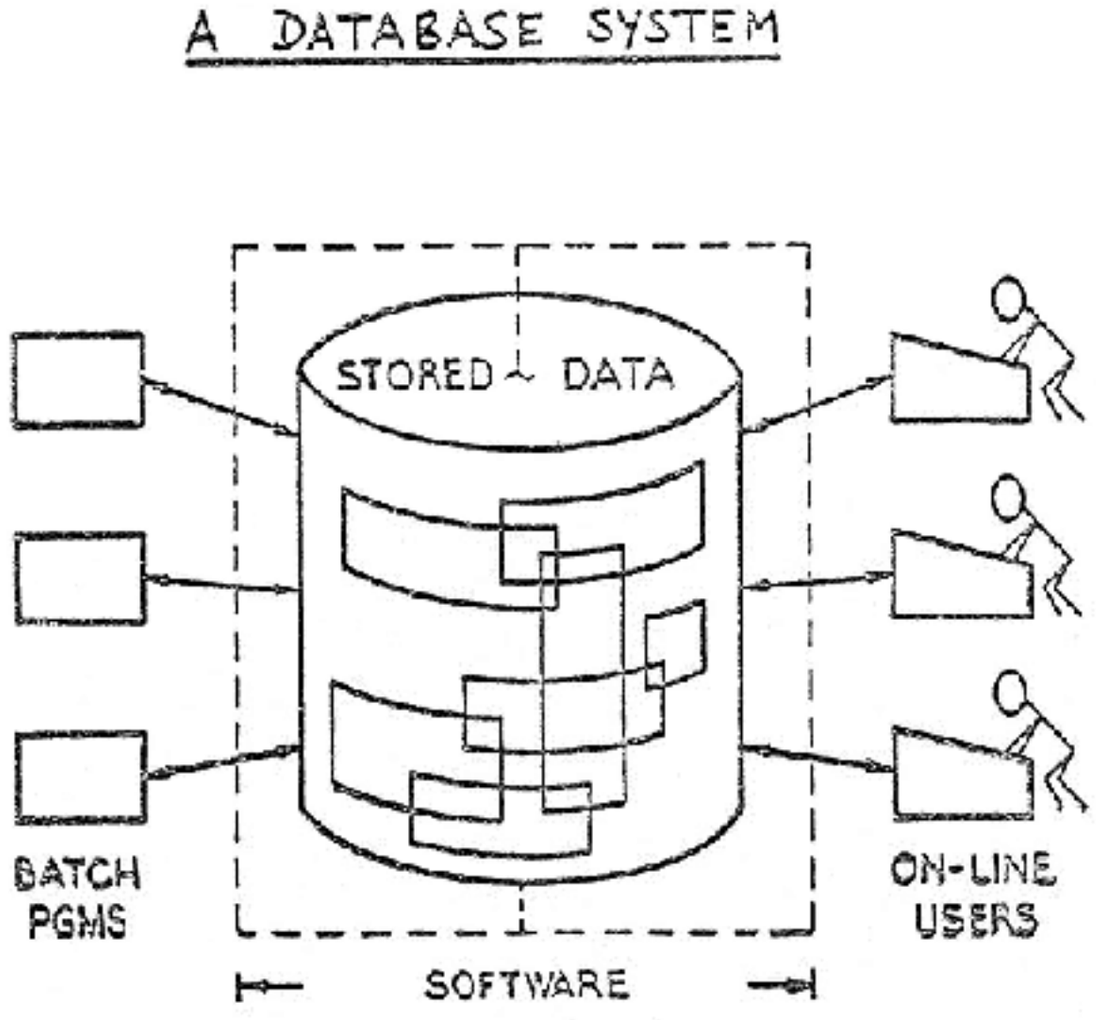
- **1966 IBM: Information Management System**
  - Designed for the Apollo space program, to store inventory, components and matterals for Saturn V rocket. It was running on an IBM mainframe computer.
  - IMS was a **hierarchical database**, relying on the "manual" navigation of a linked data set which was formed into a large network. Applications could find records by one of three methods:

1. Use of a primary key (known as a CALC key, typically implemented by hashing)
2. Navigating relationships (called sets) from one record to another
3. Scanning all the records in a sequential order

DATABASE HISTORY

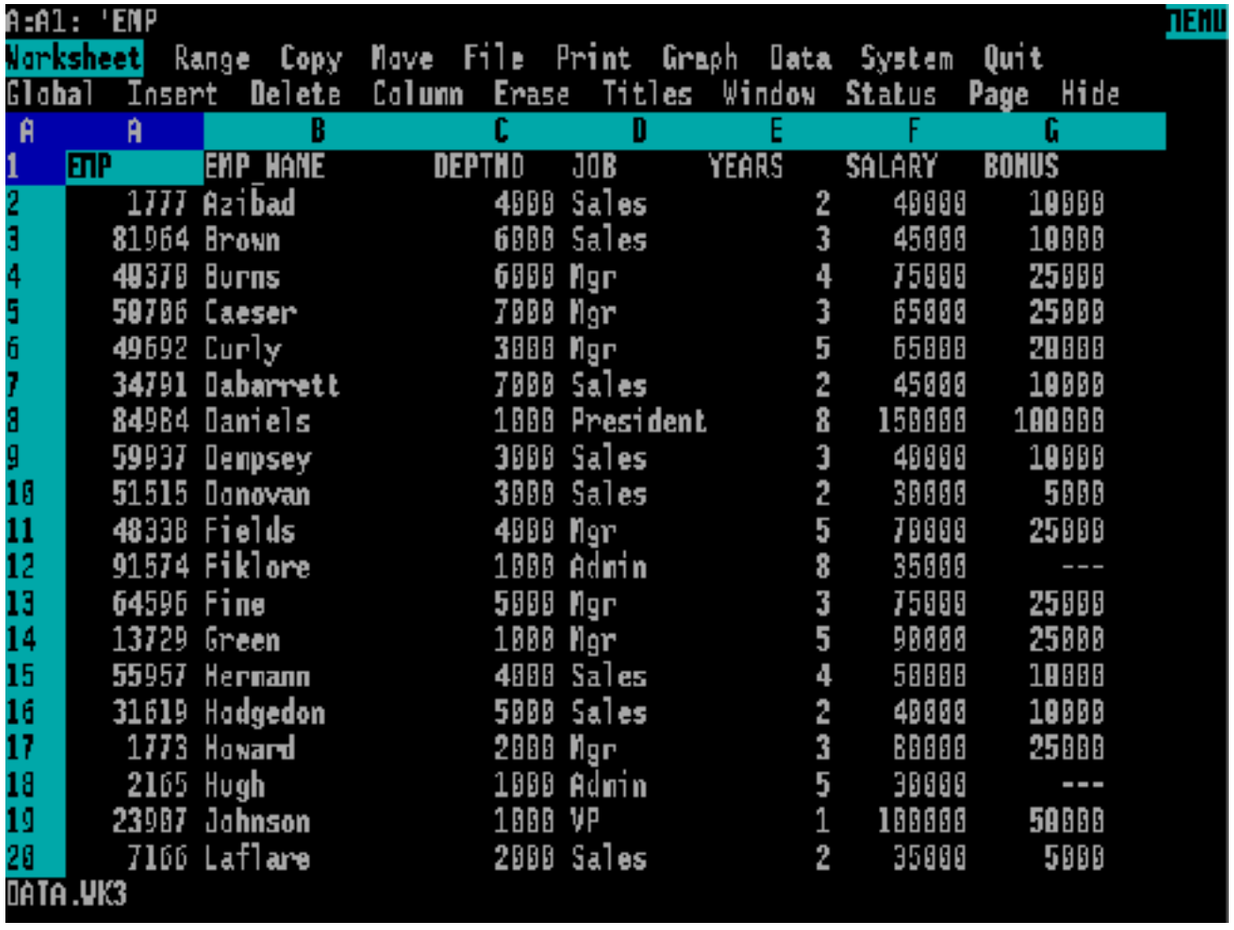
- **1970 The relational model (theoretical)**
  - Mechanical hard drives invented
  - It's sucks to search in the hierarchical DB,
  - Invented by Edgar Codd from IBM
- **1974 IBM "System R"**
  - R is for relational.
  - First implementation of SQL
  - Proving the performance and usability of the relational model





DATABASE HISTORY

- **1980 Personal Databases**
  - Desktops are introduced to the world
  - People use spread-sheet software Like IBM Lotus



DATABASE TODAY

- **Distributed RDBMS**
  - **Apacehe Hadoop**
  - **Map Reduce:** (2 stages: first "Map" a job to a node then "Reduce", where each node process and return
- **In memory RDBMS**
  - **Apache SPARK** is both distributed and uses fast in-memory computations
- **NO-SQL**
  - Non sql data stores , e.g. Graph storages, Key-value (like "dictionaries" in Python)
- **Columnar Databases:**

  Stores columns instead of rows

  Useful for data cubes and aggregations

  Becoming less popular because of the "in-memory" analytics nowadays

DATABASES TODAY

310 systems in ranking, November 2016

Rank Nov 2016	Rank Oct 2016	Rank Nov 2015	DBMS	Database Model	Score Nov 2016	Score Oct 2016	Score Nov 2015
1.	1.	1.	Oracle	Relational DBMS	1413.01	-4.09	-67.94
2.	2.	2.	MySQL	Relational DBMS	1373.56	+10.91	+86.71
3.	3.	3.	Microsoft SQL Server	Relational DBMS	1213.80	-0.38	+91.48
4.	↑ 5.	↑ 5.	PostgreSQL	Relational DBMS	325.82	+7.12	+40.13
5.	↓ 4.	↓ 4.	MongoDB	Document store	325.48	+6.67	+20.87
6.	6.	6.	DB2	Relational DBMS	181.46	+0.90	-21.07
7.	7.	↑ 8.	Cassandra	Wide column store	133.97	-1.09	+1.05
8.	8.	↓ 7.	Microsoft Access	Relational DBMS	125.97	+1.30	-14.99
9.	9.	↑ 10.	Redis	Key-value store	115.54	+6.00	+13.13
10.	10.	↓ 9.	SQLite	Relational DBMS	112.00	+3.43	+8.55
11.	11.	↑ 14.	Elasticsearch	Search engine	102.58	+3.46	+27.80
12.	12.	↑ 13.	Teradata	Relational DBMS	75.16	-1.07	-1.92
13.	13.	↓ 11.	SAP Adaptive Server	Relational DBMS	70.16	+0.68	-13.55
14.	14.	↓ 12.	Solr	Search engine	68.36	+1.79	-11.41
15.	15.	15.	HBase	Wide column store	58.74	+0.54	+2.28
16.	↑ 17.	↑ 18.	Splunk	Search engine	54.73	+1.73	+10.11
17.	↓ 16.	17.	FileMaker	Relational DBMS	53.92	-1.03	+2.19
18.	↑ 19.	↑ 19.	SAP HANA	Relational DBMS	49.27	+3.50	+9.65

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MYSQL: INTRODUCTION

- **What is MySQL?**
  - A relational database management system (RDBMS)
  - Free and open-source software written in C and C++
- **Why do we learn MySQL?**
  - It's the most common database in the web (client-server model)
  - Uses by: Facebook, Google, Twitter,
  - Is super simple (comparing to Oracle, PostgreSQL)
- **3 things you (maybe) didn't know about MySQL**
  - First version was out on 1995
  - It is actually owned by Oracle, since 2010
  - When it happened, one of the founders quit and forked **Maria-DB** which is still free under the GNU license

MYSQL: CONNECT REMOTELY

- **SQL Clients**
  - CLI (command-line interface), mainly for 1337 h4x0r$
  - SQL Software (i.e. workbench, Heidi, Dbeaver)
  - PhpMyAdmin (web based)
- **For security reasons, connection is over SSH, remember?**
- **FYI:** Our MySQL server is an internal sever and you will use it both in the final project and in HW#1

WAIT-A-MINUTE: SSH?

Secure Shell (SSH)

★A network (layer 7) protocol

★Providing secured channel to a remote host.

★Built-in client in Unix based systems

★Putty is required in Windows based systems.

MYSQL: CONNECT REMOTELY (+SSH)

- **Command line connection (unix)**

```
➜  ~ ssh amitsome@nova.cs.tau.ac.il
amitsome@nova.cs.tau.ac.il's password:
Last login: Mon Mar 14 22:44:02 2016 from 37.142.245.121
nova 1%
```

```
[nova 1% mysql -h mysqlsrv.cs.tau.ac.il -u sakila -p
[Enter password:
 Welcome to the MySQL monitor.  Commands end with ; or \g.
 Your MySQL connection id is 1368667
 Server version: 5.5.35-1ubuntu1-log (Ubuntu)
```

MYSQL: CONNECT REMOTELY (+SSH)

- **Command line connection (unix)**

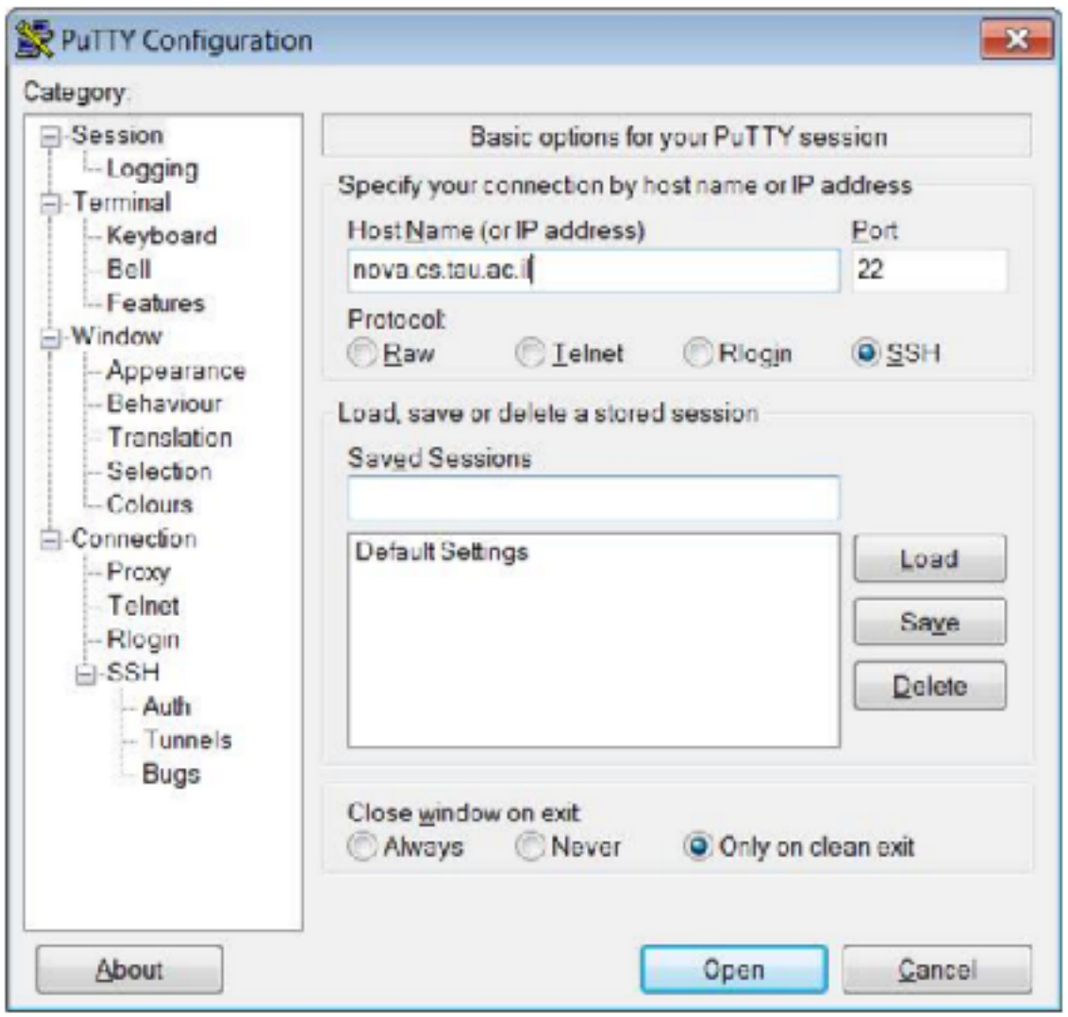
```
[mysql> select 1;
+---+
| 1 |
+---+
| 1 |
+---+
1 row in set (0.00 sec)
```

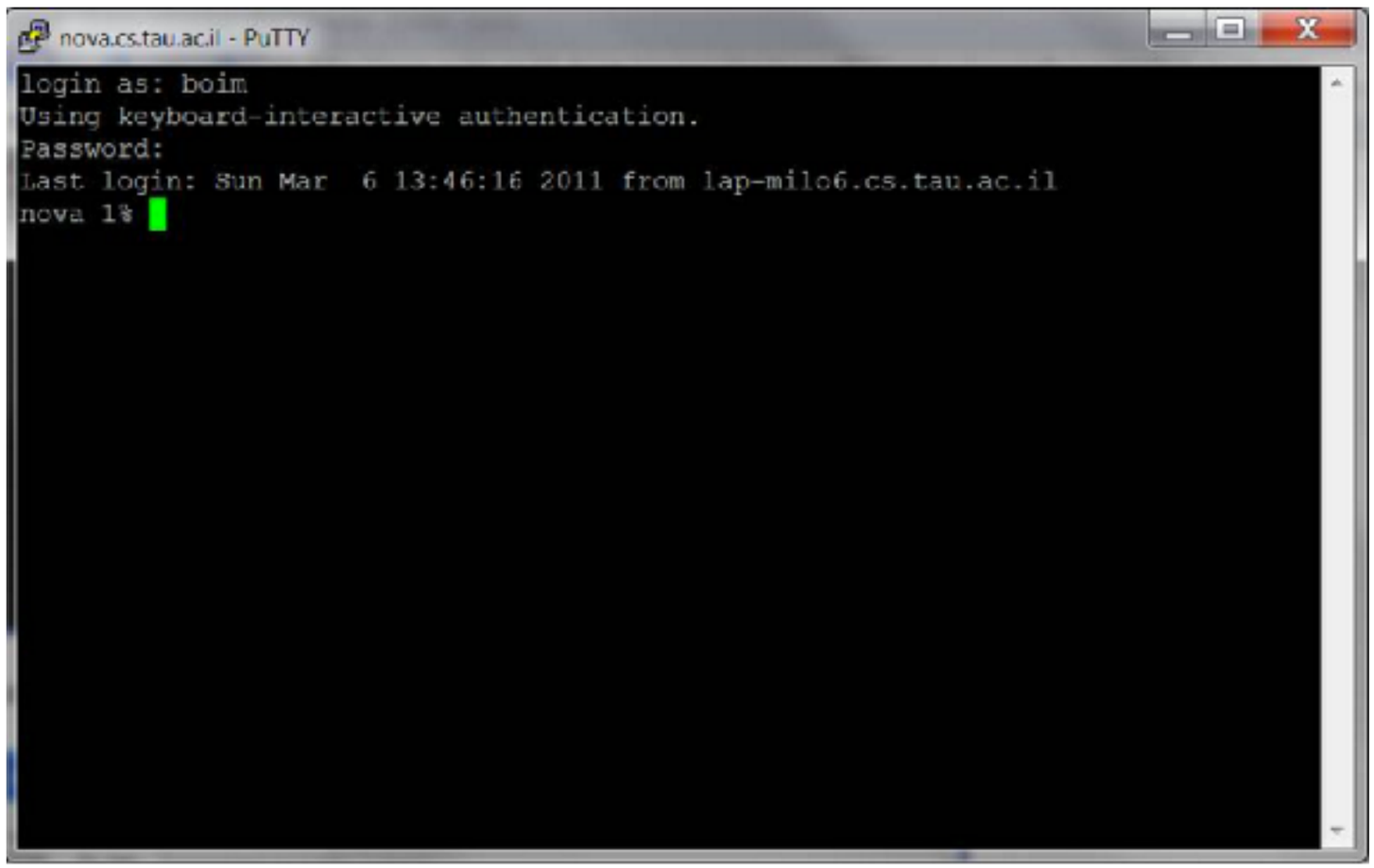
- Use Mysql CLI tool to connect to mysqlsrv.tau.ac.il

MYSQL: CONNECT REMOTELY (+SSH)

Command line connection (Windows)

- Using Putty to Nova





MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (Windows, the hard way)

1. Download and install MySQL server for Windows from the official website, see the last slides for a step-by-step manual.

2. Read carefully the connection guide (here)

3. Establish a **Tunnel** in putty as usual

4. In the Tunnel configuration, add a **Port Forwarding rule**:

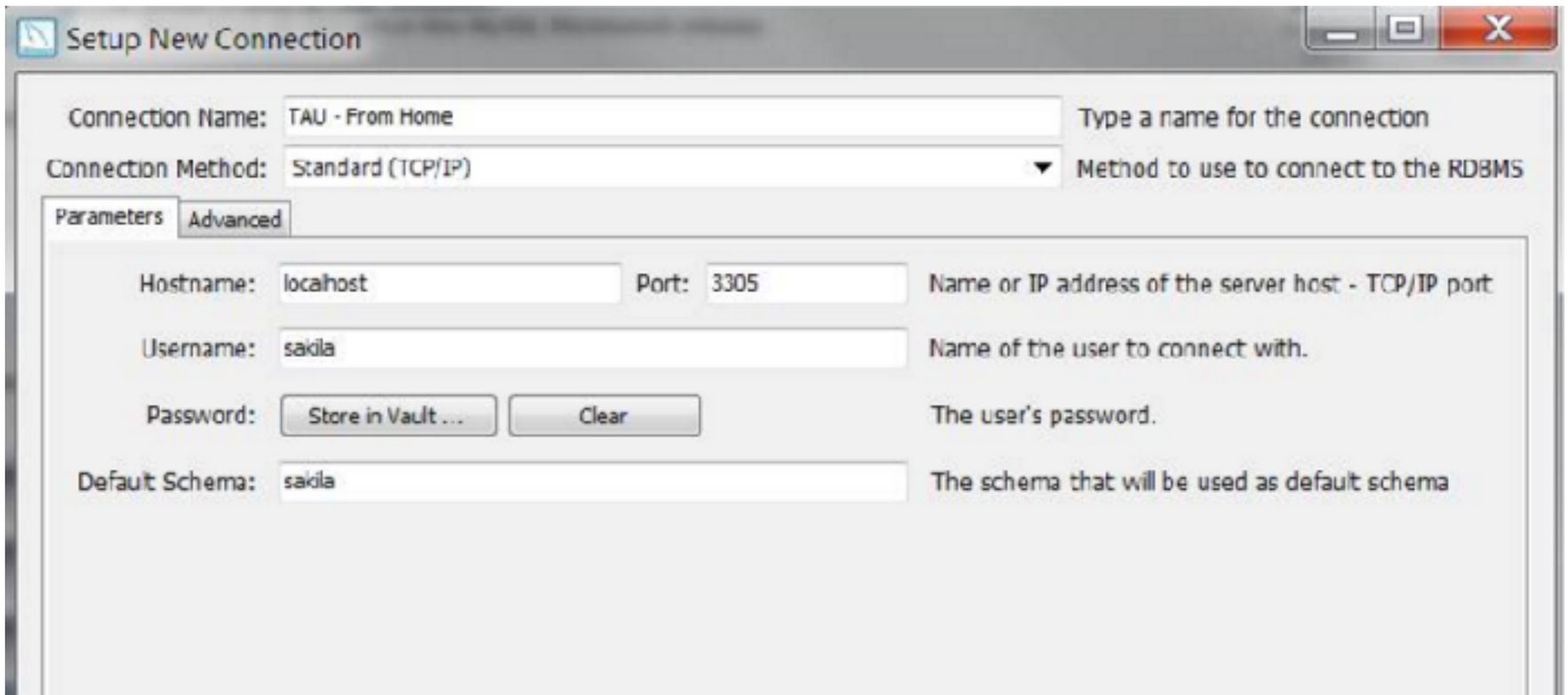
   - from local port 3305
   - to mysqlsrv.cs.tau.ac.il, port 3306

MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (Windows, the hard way)

4.Open Workbench, and create a new connection

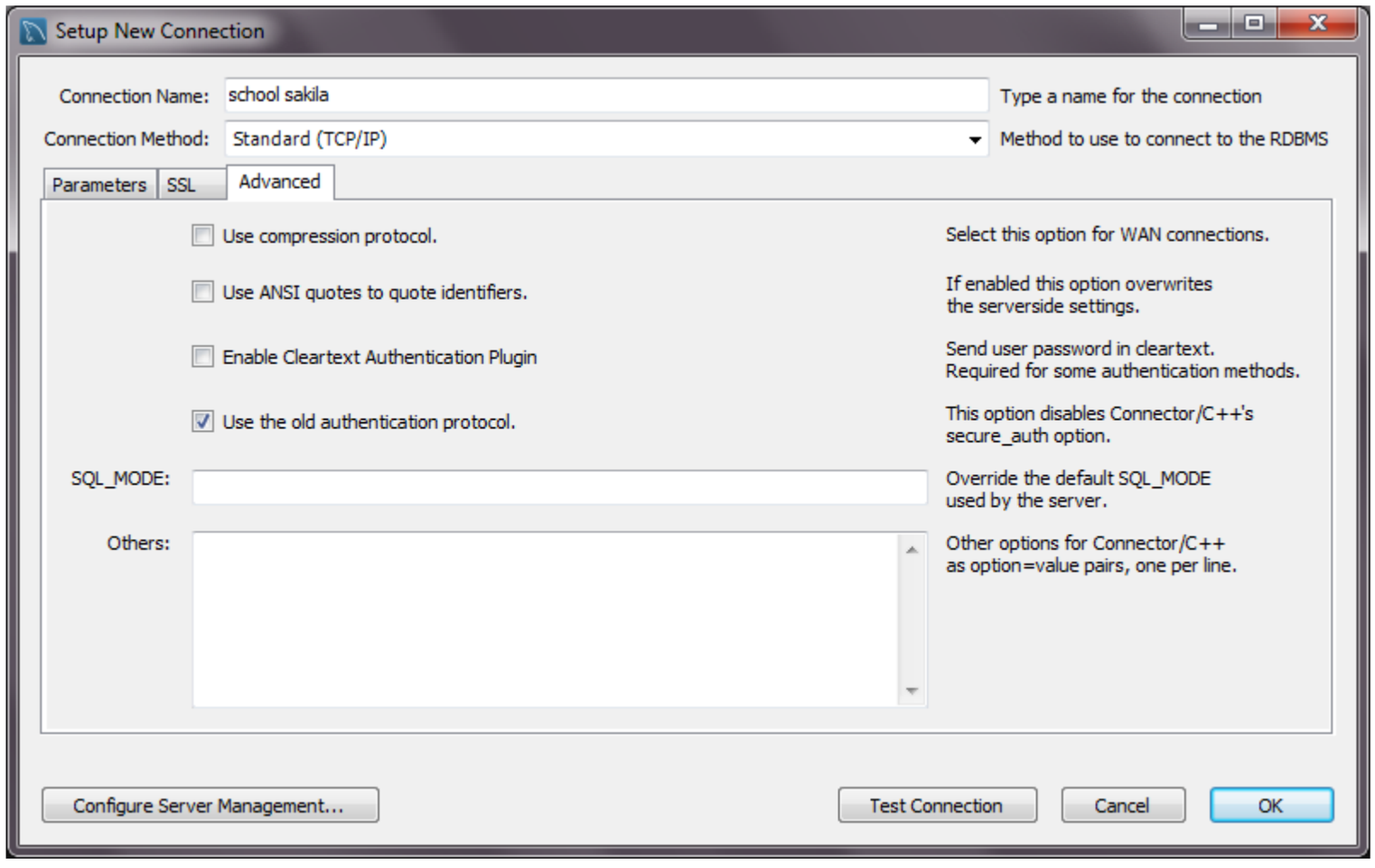
5.Configure the software to connect to your local host at port 3305 (instead of mysqlsrv.cs.tau.ac.il)



MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (Windows, the hard way)

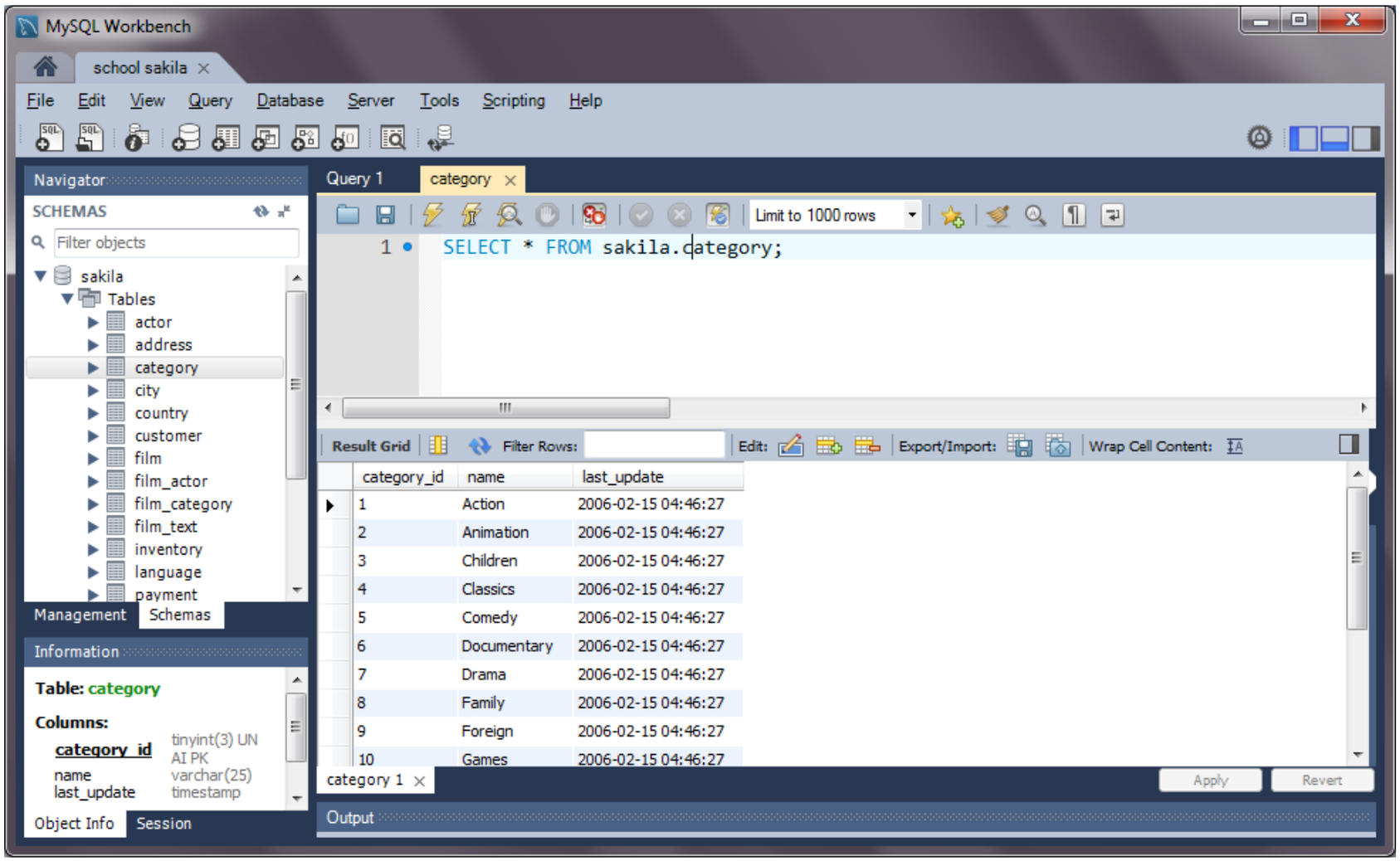
6. Support the old authentication protocol for some reason.



MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (Windows, the hard way)

7.Start querying for hw# 1



MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (All platforms)

1.Install an SQL client that support SSH Tunnel

★Windows: Heidi SQL

★Mac: Sequel Pro

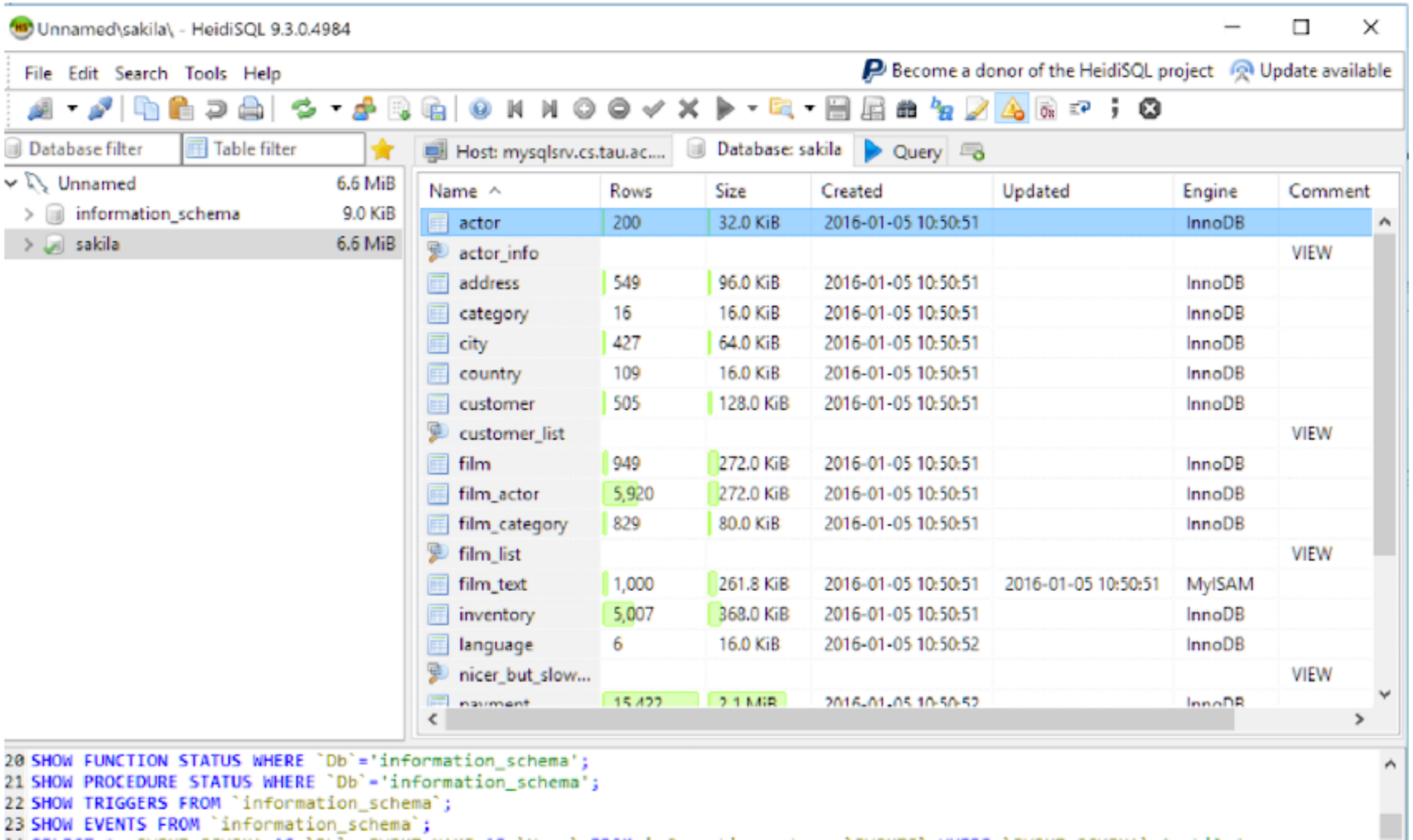
★ALL Platforms: DBeaver

2.Configure the SSH server in the option tab

3.Start querying

MYSQL: CONNECT REMOTELY (+SSH)

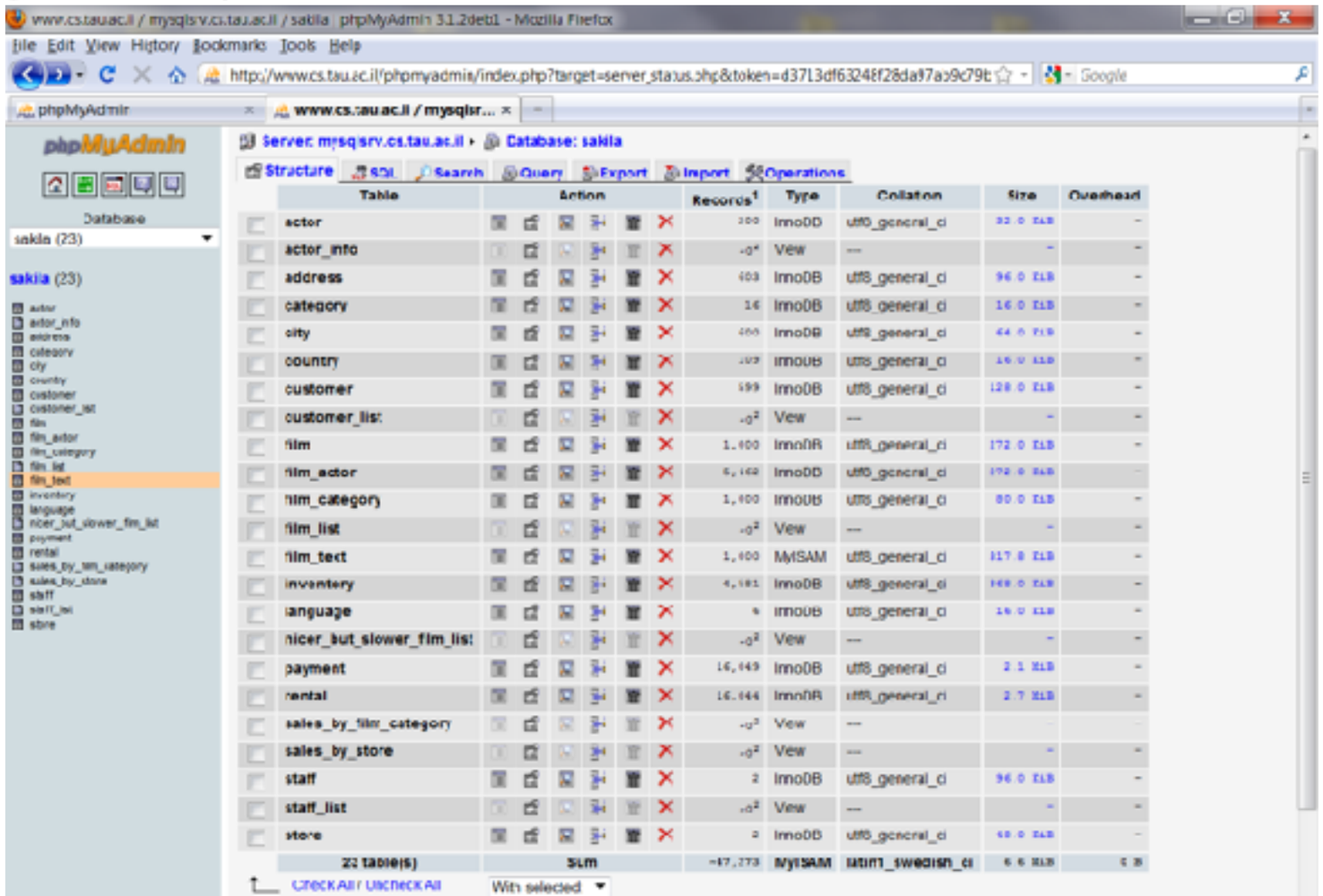
SQL Software (All platforms)



MYSQL: CONNECT REMOTELY

phpMyAdmin

Web based MySQL client, very common in shared hosting web platforms.



MYSQL: META-DATA

- **Information_schema**
  - MySQL server has a default database called "information_schema"
  - TABLES table contains information about each table in the database. e.g, name, type,number of rows etc.
  - COLUMNS table contains information about each column, such as the table it's belong to, the data type, etc.
  - USER_PRIVILEGES table contains information about the users listed in the database (do not confuse with web-users accessing the website.

MYSQL: META-DATA

- **MySQL Data types**
  - Each column has a predefined type and possibly a default value
    - ★Integers: TINYINT, MEDIUMINT, BIGINT
    - ★Strings: VARCHAR (strings), BLOB (for binaries)
    - ★Dates: TIMESTAMP, DATE, DATETIME
  - Set when the database schema is created

MYSQL: META-DATA

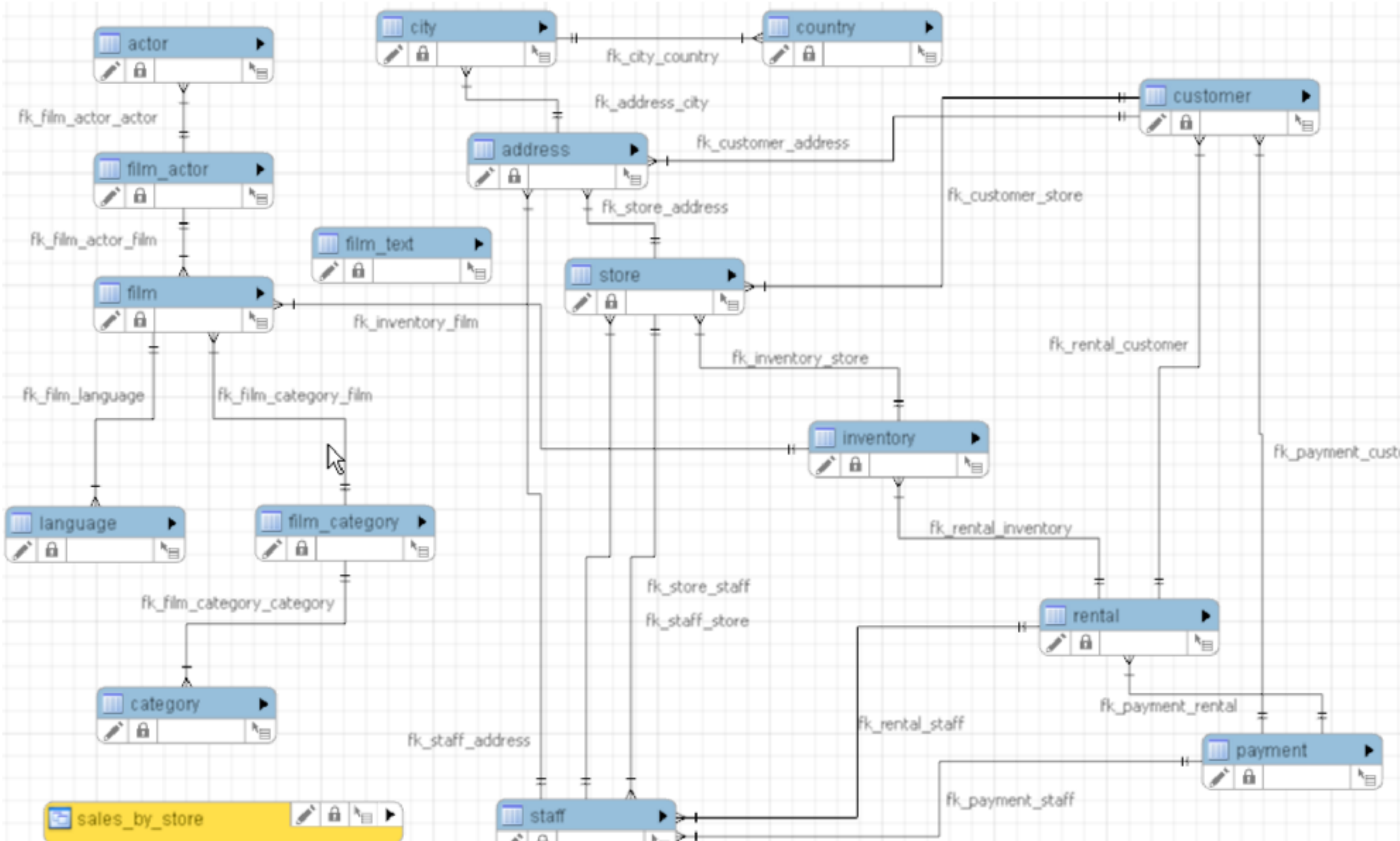
- **MySQL users privileges**
  - Root user: granting permissions, creating users, altering creating and deleting data
  - Application users: usually read only, no grant.
  - Don’t every use root user in a DB connection string (we will discuss it over the next recitations)

HW#1: SQL QUERIES

You will be writing SQL queries and execute them over the Sakila Database.

- Address: mysqlsrv.cs.tau.ac.il. User: sakila, password: sakila, DB name: sakila
- First establish ssh connection, or just com to UNI to work.
- Note that the schema and data tuples on our server might be different than other resources you will find.
- The DB server is not always stable. Contact system for support and just *start early*

MYSQL: SAKILA SCHEMA



MYSQL: SAKILA SCHEMA

Example Query:

```
mysql> SELECT CONCAT(customer.last_name, ', ', customer.first_name) AS customer,
    -> address.phone, film.title
    -> FROM rental INNER JOIN customer ON rental.customer_id = customer.customer_id
    -> INNER JOIN address ON customer.address_id = address.address_id
-> INNER JOIN inventory ON rental.inventory_id = inventory.inventory_id
-> INNER JOIN film ON inventory.film_id = film.film_id
-> WHERE rental.return_date IS NULL
-> AND rental_date + INTERVAL film.rental_duration DAY < CURRENT_DATE()
-> LIMIT 5;
```

MYSQL: SAKILA SCHEMA

Example Query:

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    -> WHERE rental.return_date IS NULL
    -> AND rental_date + INTERVAL film.rental_duration DAY < CURRENT_DATE()
    -> LIMIT 5;
```

Results:

```
+------------------+--------------+--------------------+
| customer         | phone        | title              |
+------------------+--------------+--------------------+
| OLVERA, DWAYNE   | 62127829280  | ACADEMY DINOSAUR   |
| HUEY, BRANDON    | 99883471275  | ACE GOLDFINGER     |
| BROWN, ELIZABETH | 10655648674  | AFFAIR PREJUDICE   |
| OWENS, CARMEN    | 272234298332 | AFFAIR PREJUDICE   |
| HANNON, SETH     | 864392582257 | AFRICAN EGG        |
+------------------+--------------+--------------------+
```

MYSQL: SAKILA SCHEMA

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| HANNON, SETH     | 864392582257 | AFRICAN EGG        |
+------------------+--------------+--------------------+
```

YOUR BEST FRIENDS

- MySQL is the most common database used on the web.
- Therefore, **stackoverflow** is your friend.
- Another good friend you got : w3schools.com. for everything you need regarding web development and basic SQL use.
- MySQL cheatsheet:
  - https://en.wikibooks.org/wiki/MySQL/CheatSheet

Install MySQL at Home

- MySQL Community Server

  http://www.mysql.com/downloads/mysql/

Registration is Optional

Begin Your Download - mysql-installer-community-5.6.22.0.msi

Login Now or Sign Up for a free account.

An Oracle Web Account provides you with the following advantages:

- Fast access to MySQL software downloads
- Download technical White Papers and Presentations
- Post messages in the MySQL Discussion Forums
- Report and track bugs in the MySQL bug system
- Comment in the MySQL Documentation

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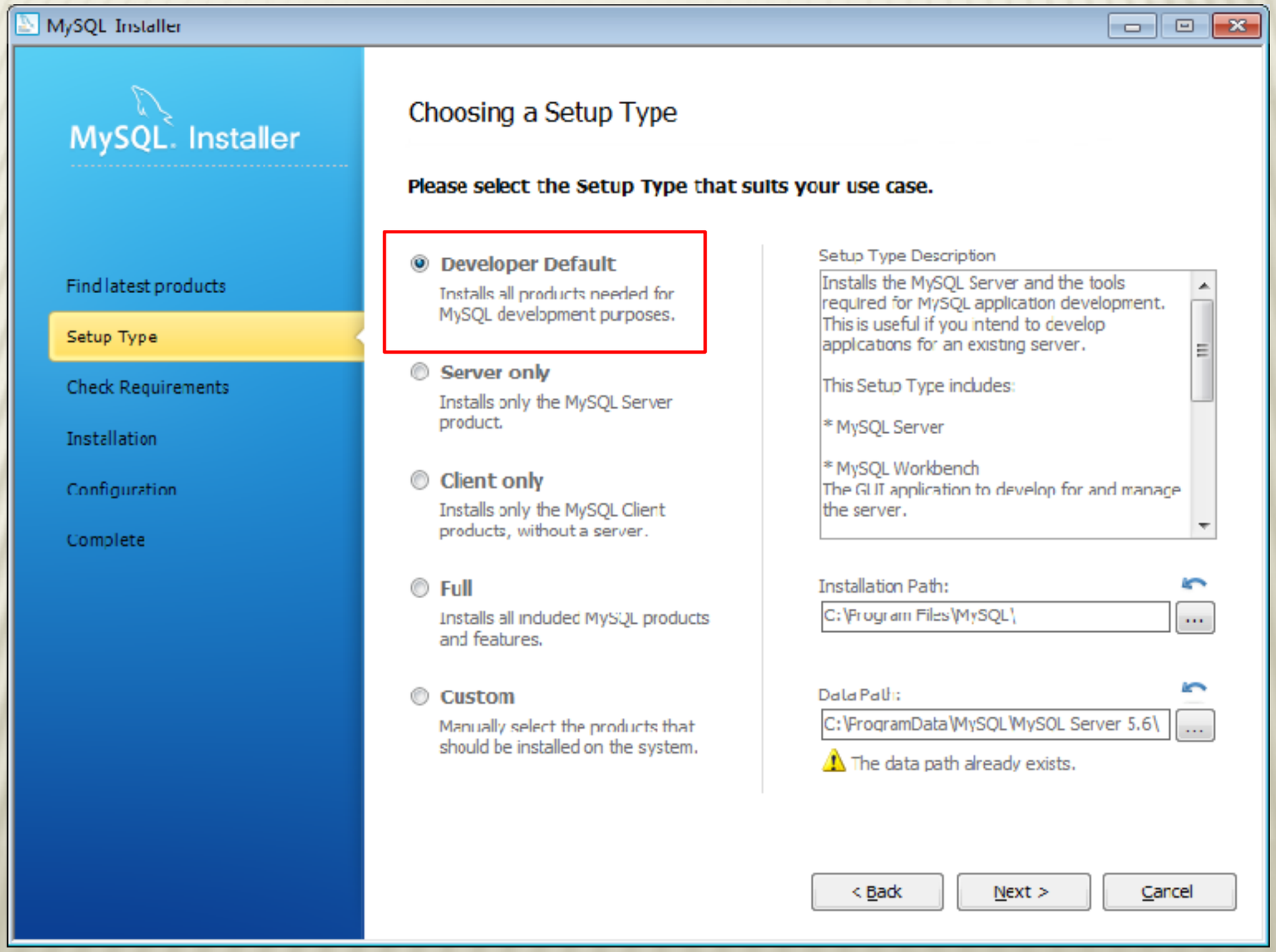
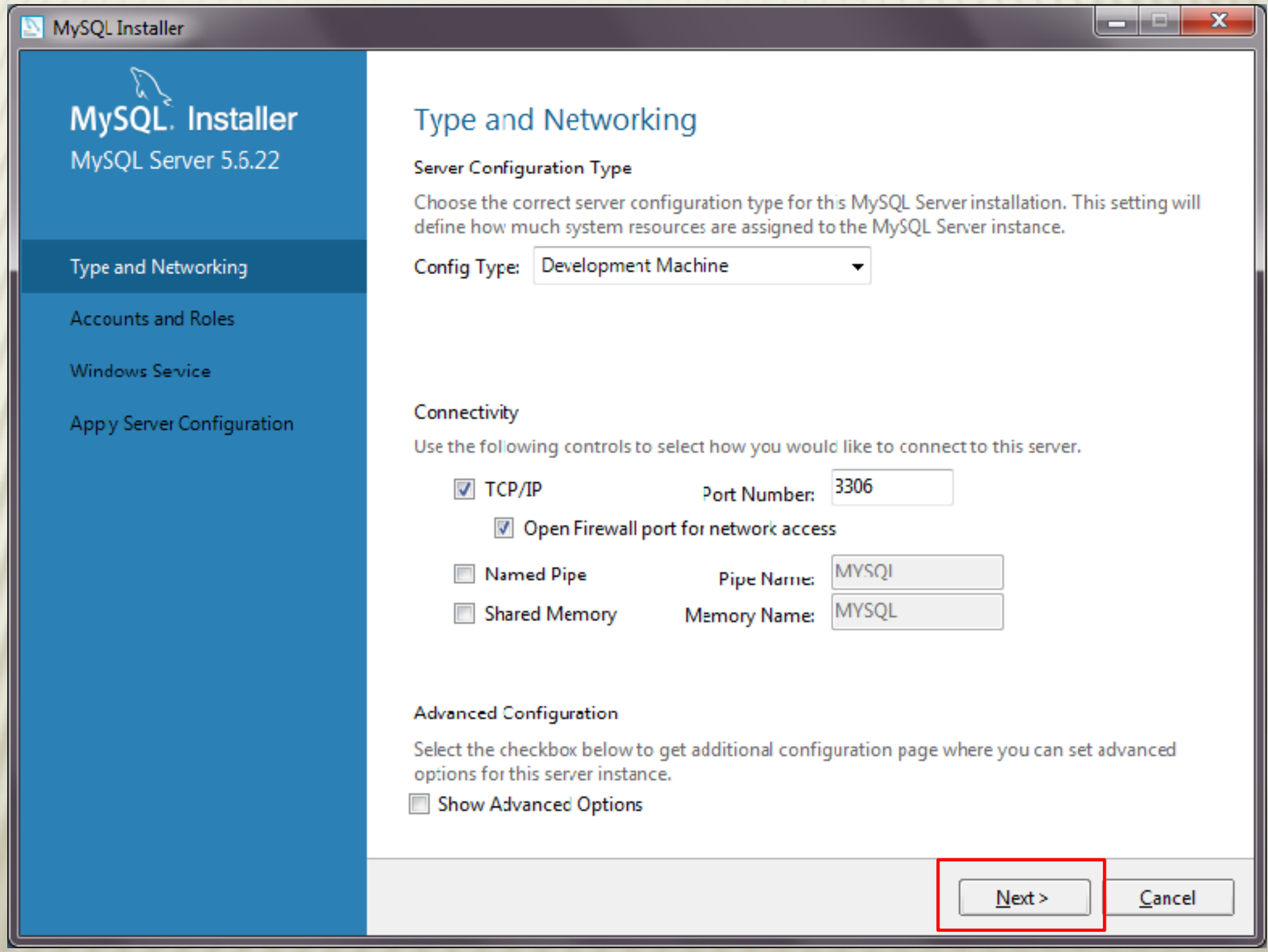
MySQL.com is using Oracle SSO for authentication. If you already have an Oracle Web account, click the Login link. Otherwise, link and following the instructions.

No thanks, just start my download.

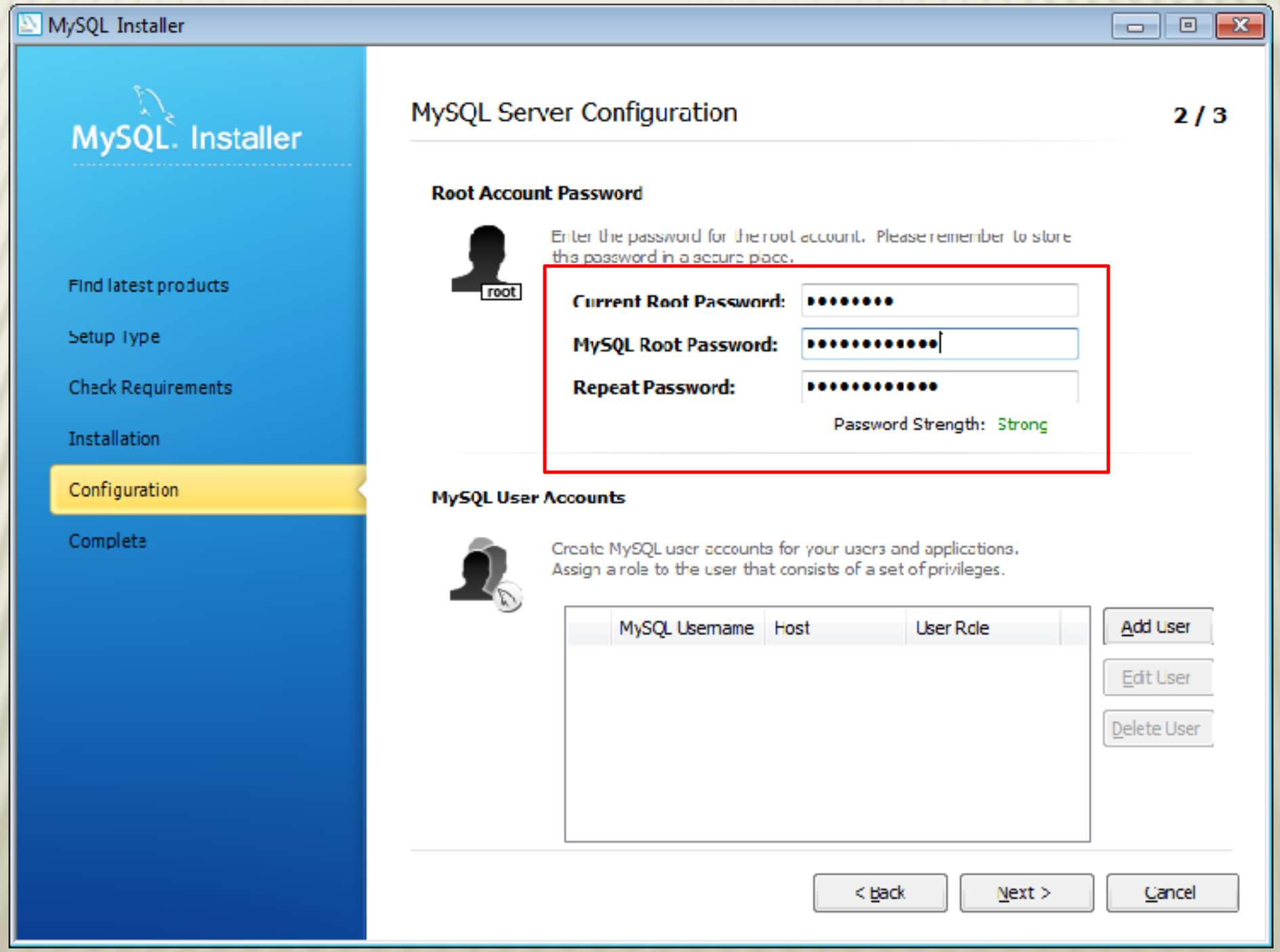
Installation using an Installer



Configuration

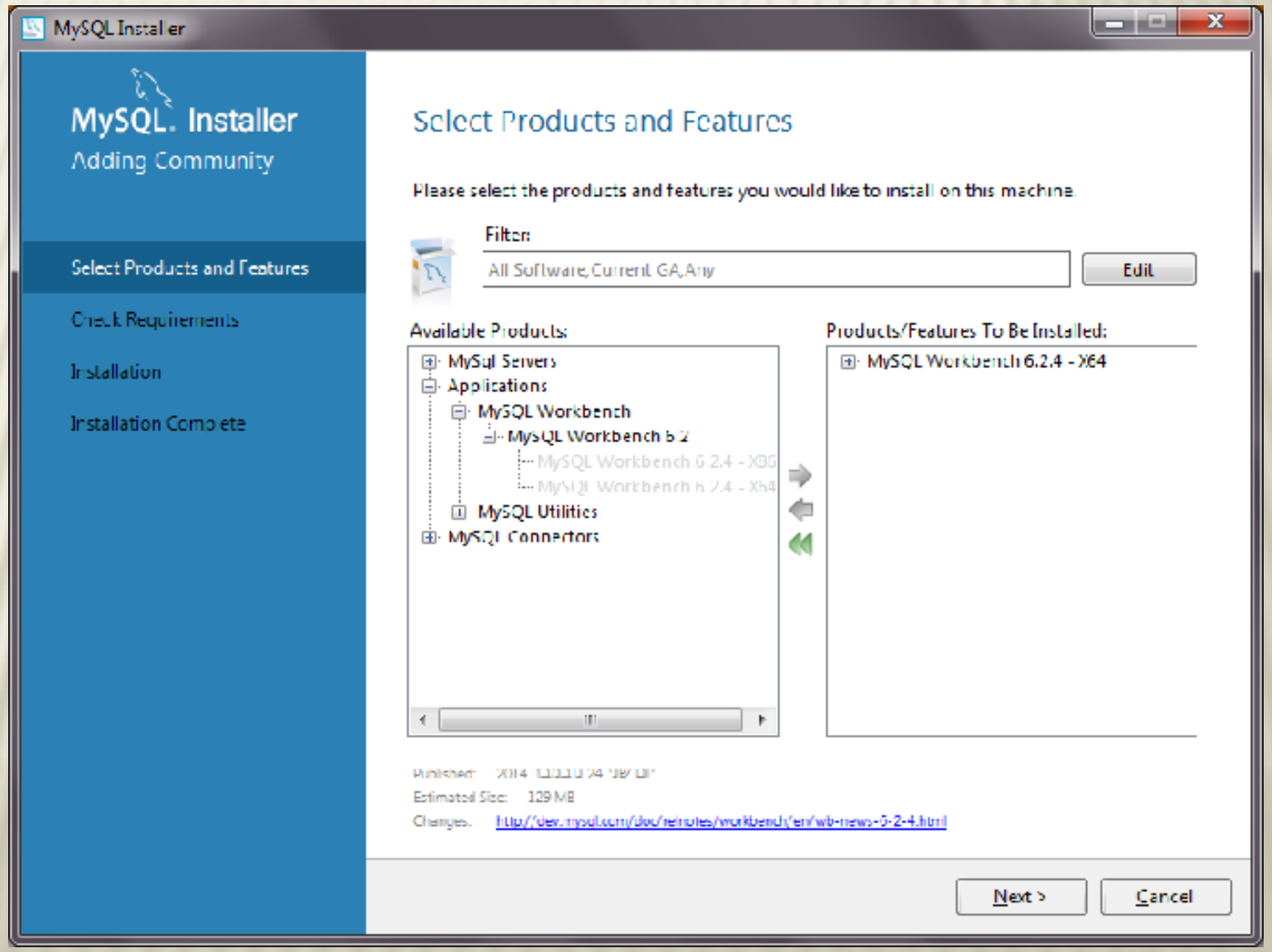


Installation using an Installer



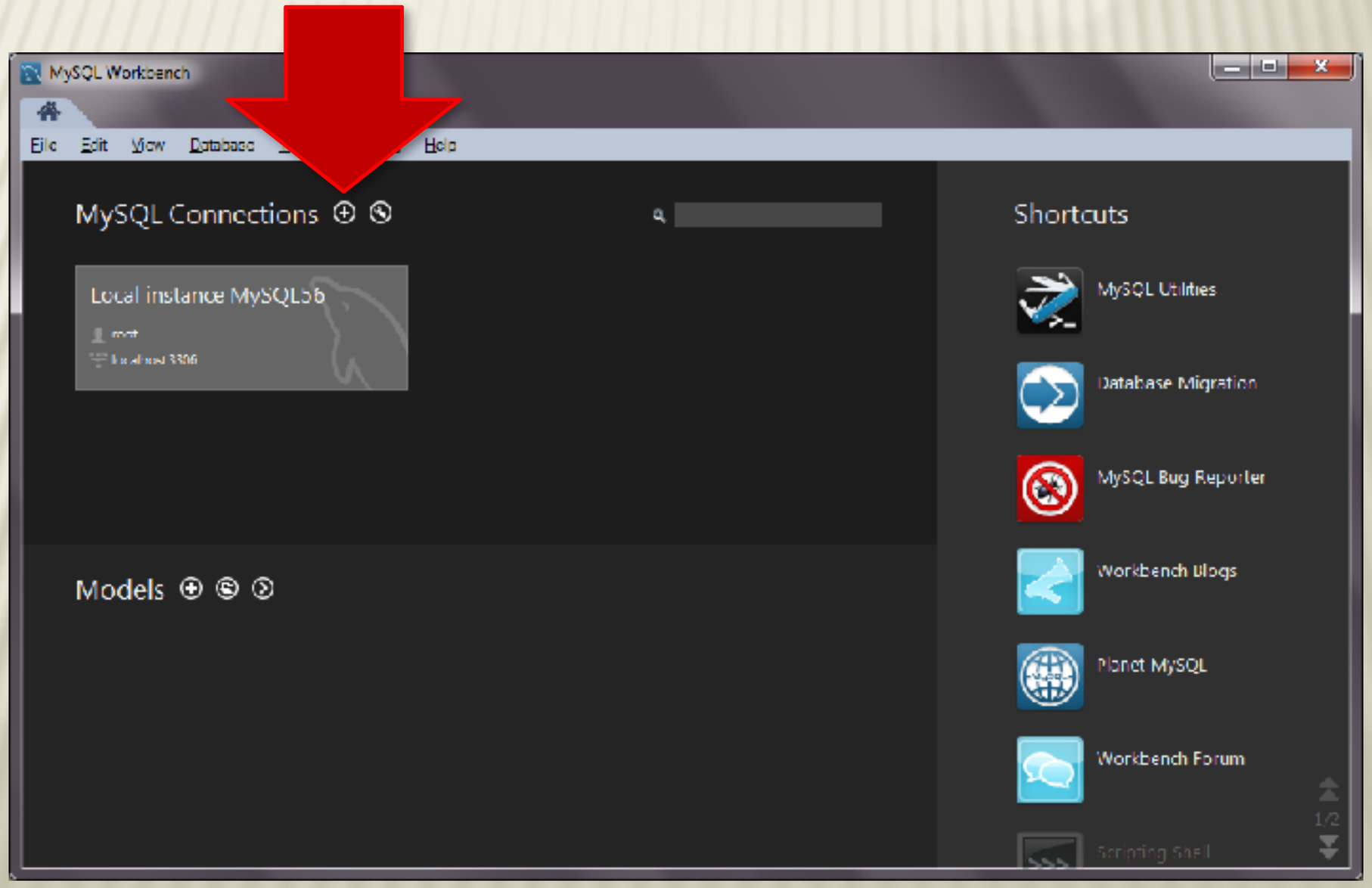
MySQL Workbench

- Make sure to install server, workbench and examples

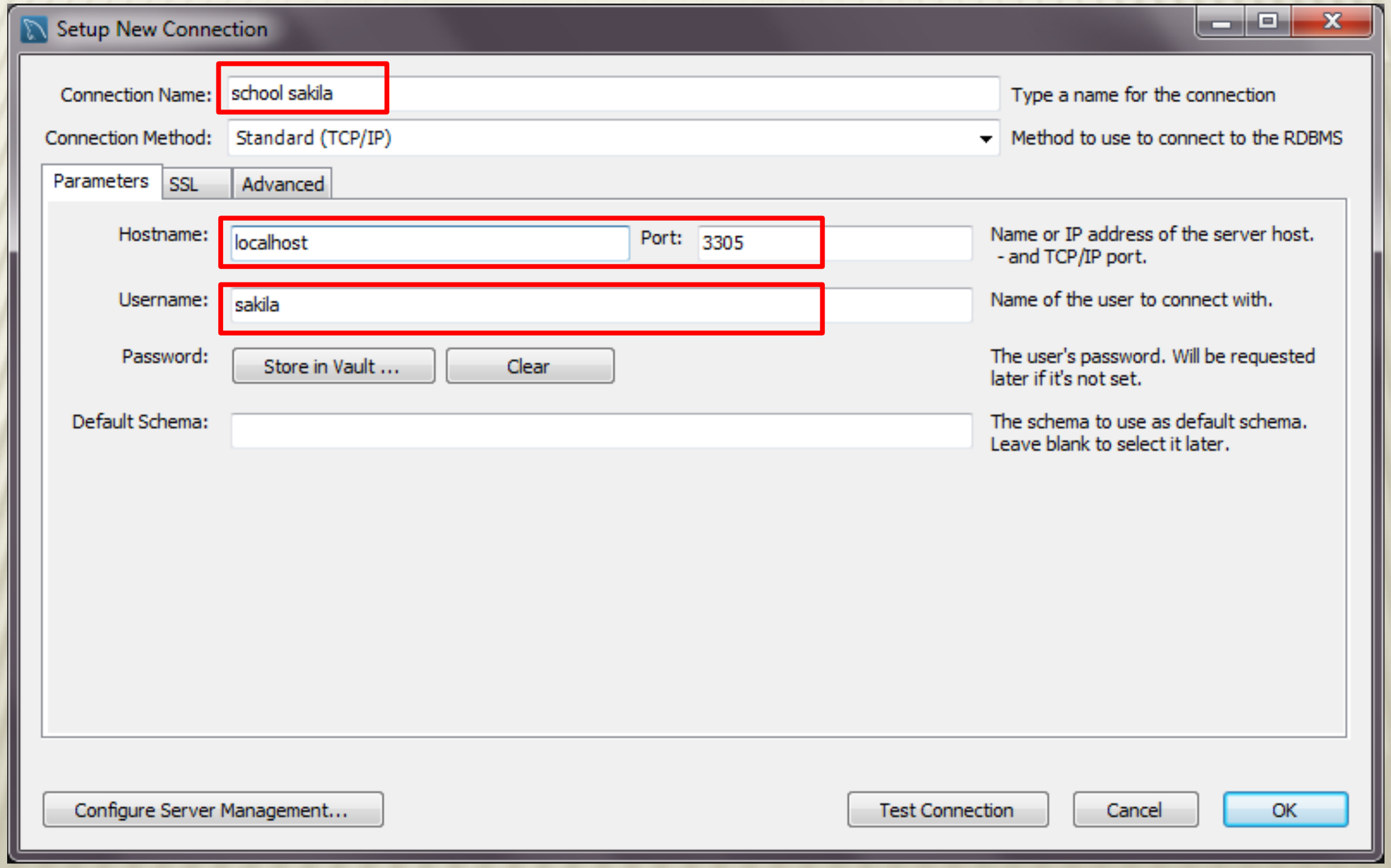


Example: connecting to school server

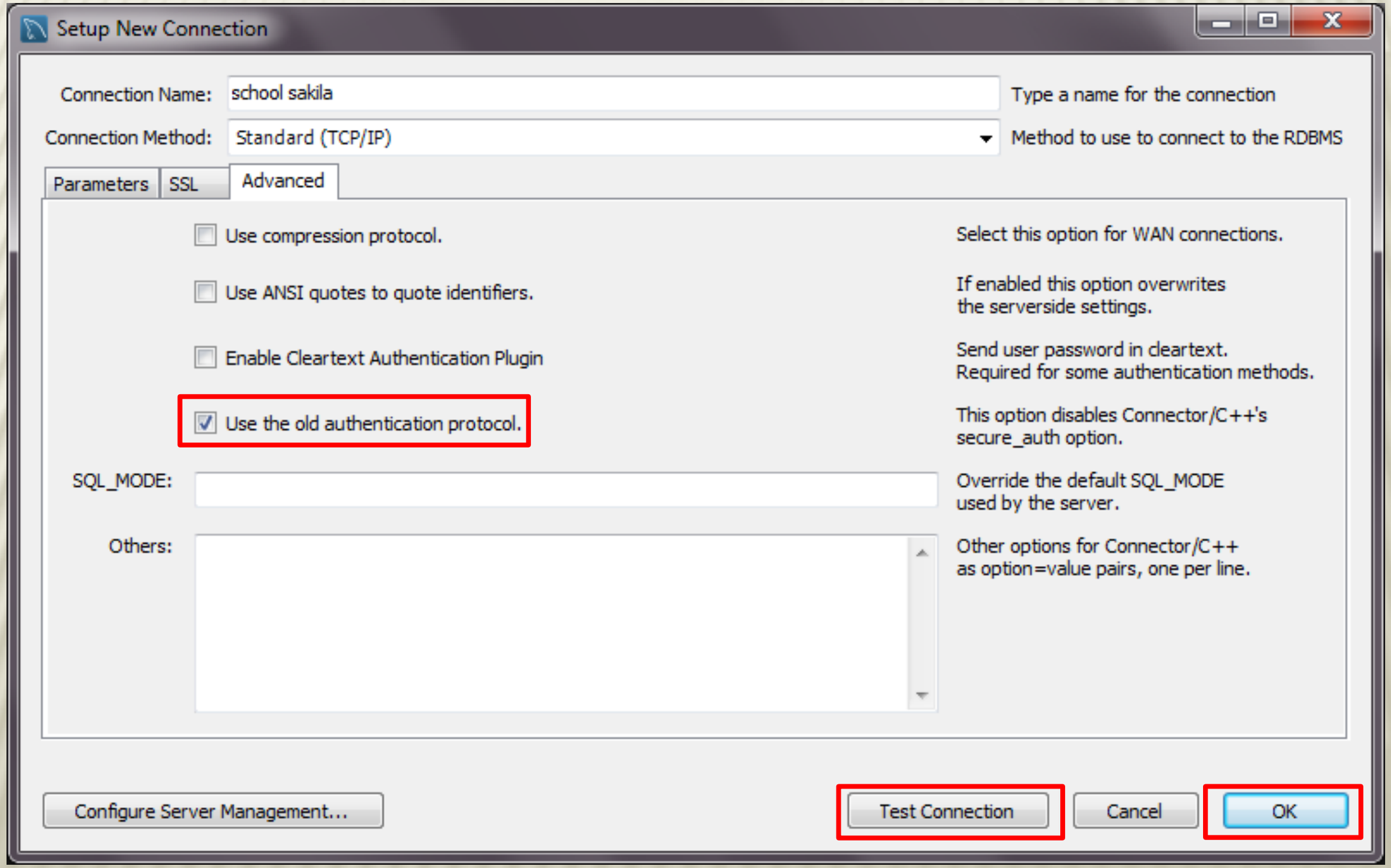
- Open the tunnel!
- Then open workbench and create new connection



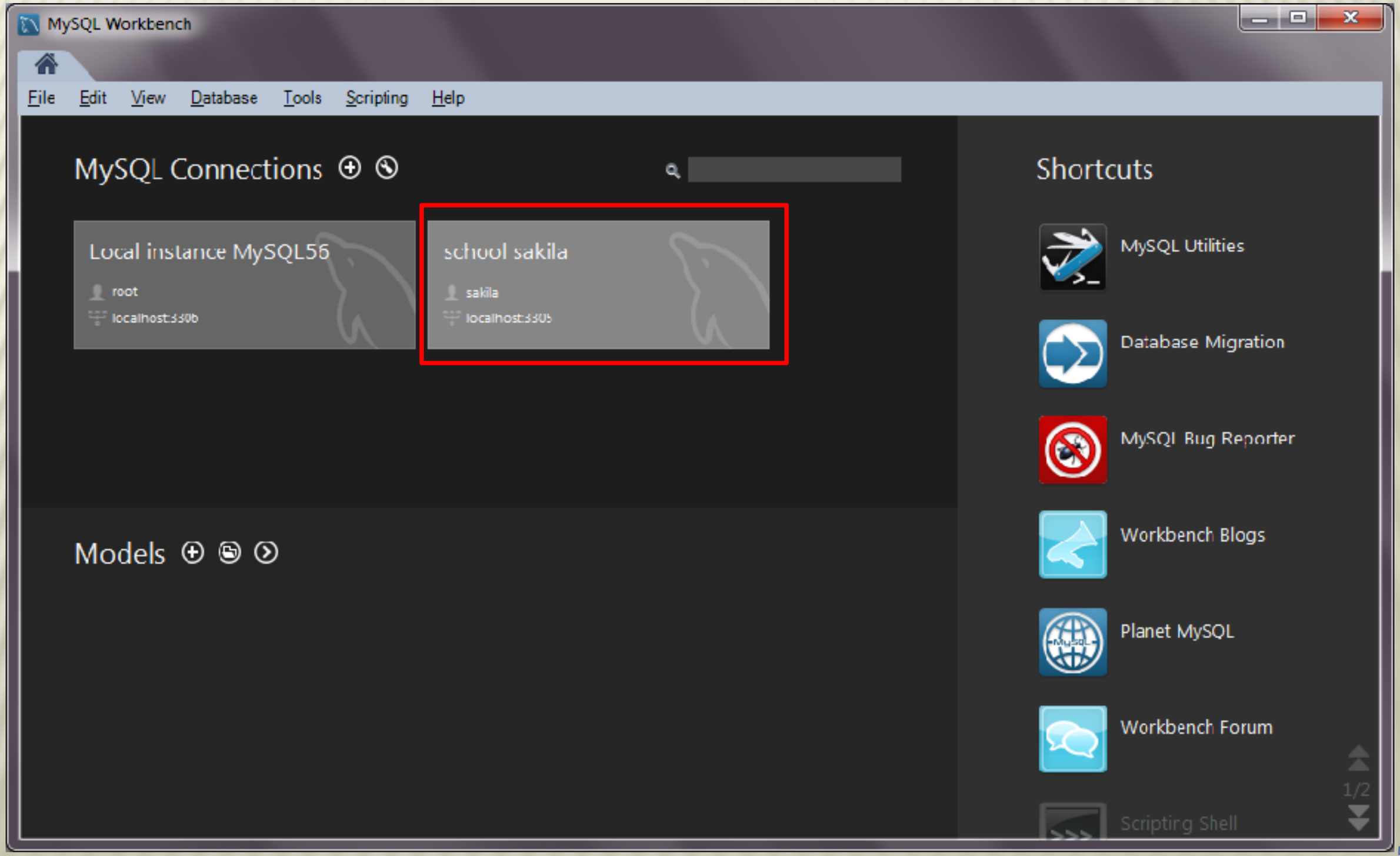
Configure the connection



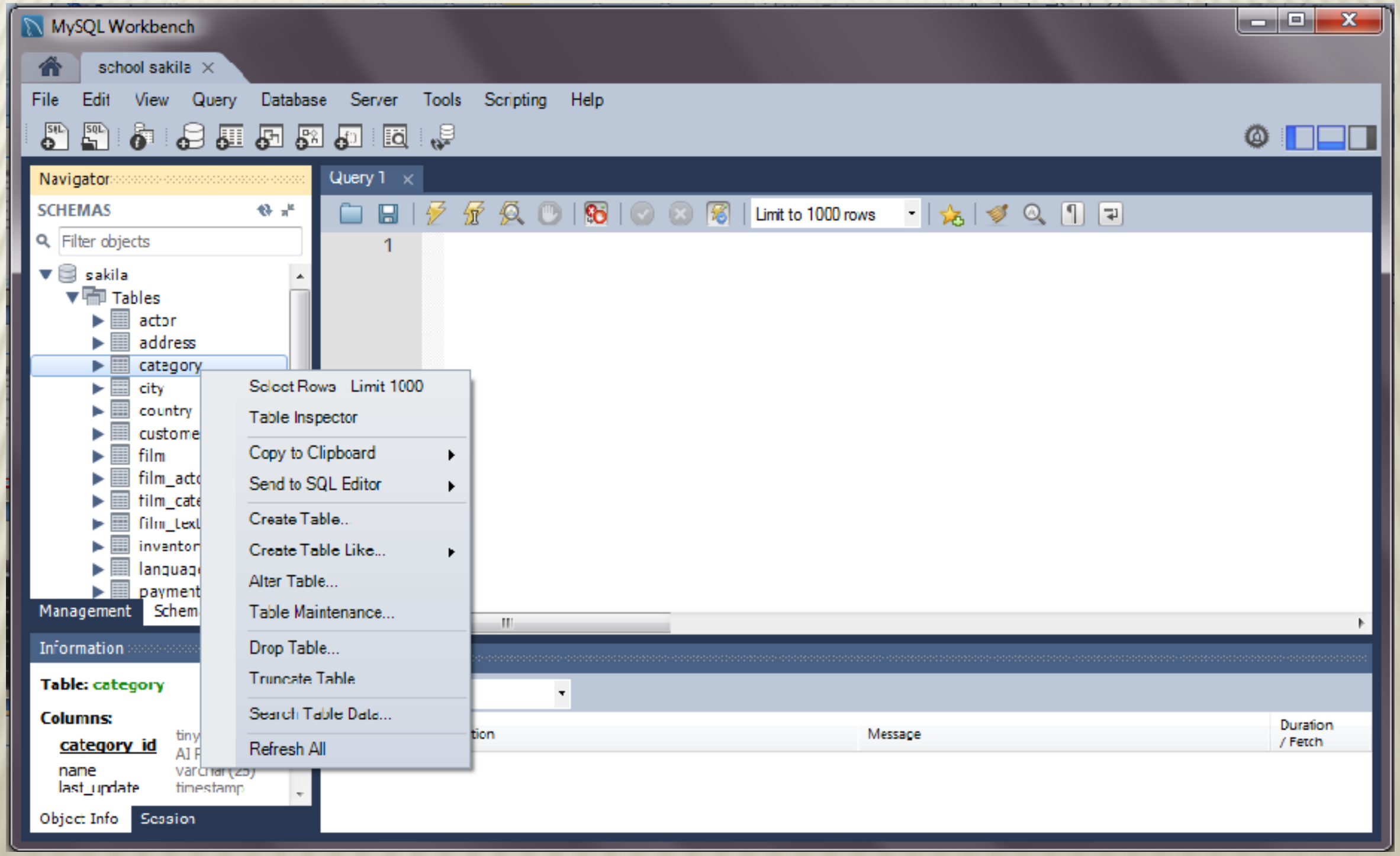
Support old authentication protocol



Open the new connection



Now you can query the SQL data



... and the result